Report of the AARMS-CRM workshop on Sustainability of Aquatic Ecosystem Networks

This workshop on sustainability of aquatic ecosystem networks took place in Fredericton, New Brunswick, on October 22 - 25, 2013. It was one of ten workshops within the pan-Canadian thematic year on "Models and Methods in Ecology, Epidemilology and Public Health (http://www.crm.umontreal.ca/M2E2/). The workshop was organized by Frithjof Lutscher (Ottawa) and James Watmough (University of New Brunswick) and was supported by AARMS, CRM, NSF and SMB.

Aquatic ecosystems, freshwater and marine, supply tremendously important ecosystem functions from food supply to transportation and recreation. These ecosystems are imperiled due to changing climate and human activities. The goal of this workshop was to bring together researchers from mathematical modeling and quantitative biology to exchange recent empirical results, novel ideas and modeling frameworks on the topics of sustainability in aquatic system with focus on spatially distributed systems.

Participants, 10 regional, 5 national and 12 international, ranged from mathematicians and modelers to theoretical and empirical biologists as well as government scientists, and topics spanned a wide range of temporal and spatial scales. Connectivity was a recurring theme, characteristic length scales were discussed frequently, invasive species as well as intended reintroduction of extirpated species were discussed.

The opening talk by Kurt Anderson (UC Riverside) introduced the question of scales in a single river or stream. How far downstream will a point-disturbance in the benthic community be felt? He presented a simple model for this response length and used the theory of transfer functions to explore responses to more complex disturbances. He pointed out the frequent mismatch in scales between management actions and management goals. Jonathan Sarhad (UC Riverside) presented ideas of ecological dynamics on river networks and their connection to quantum graphs. A reaction-advection-diffusion equation describes the population dynamics within each reach, and the equations are coupled at confluences. Yasmine Samia (Ottawa) continued the topic of persistence on a river network comparing topological measures (the dentritic connectivity index) with ecological quantities (the population growth rate) under various conditions.

Les Stanfield (Ontario Ministry of Natural Resources) presented his vision of a unified ecohealth network, based on standardized protocols and open access data bases, as well as a transparent adaptive management cycle. He reported his success with the SMART regional monitoring program

of wadeable streams in Ontario. Andrew Paul (Fish and Wildlife, Alberta) reported on monitoring and assessing fish stocks in Alberta where a rapidly growing population and industrial demands for freshwater put multiple pressures on wildlife and cumulative effects are often difficult to assess. In addition, management action such as the closure of fisheries may infringe on first nations treaty rights and are difficult to negotiate.

Daniel Boiclair (Montreal, HydroNet) began the second day with a study on the impact of hydropower on fisheries. While fisheries are in decline hydropower is expected to increase massively; both tap into renewable resources. The question is how to reconcile the two. Pierre Girard (UFMT, Brazil) continued the topic of the effect of dams on fish populations with a case study from Brazil in the Pantanal wetland (world heritage) in the upper paraguay basin. Qihua Huang (Alberta) presented a study on how homing fidelity of migratory fish can affect their persistence in a river network.

The afternoon focused on more mathematical aspects again. Gunog Seo (Colgate) presented a model for the Asian clam invasion in North America, with five coupled delayed reaction-advection diffusion. Olga Vasilyeva (Christopher Newport University) presented an impulsive reaction-diffusion model for stream insects with a winged adult stage. Frithjof Lutscher (Ottawa) modeled transport and uptake of nutrients from the water column in heterogeneous conditions.

For Thursday and Friday, the focus of the workshop shifted from freshwater systems to marine systems. The opening speaker was Alan Hastings (UC Davis) who talked about connectivity and persistence in marine systems. His metapopulation set-up led to some nice applications of matrix theory. Inclusion of stochasticity gives rise to some very hard problems about products of random matrices. Myriam Barbeau (UNB) presented exicting empirical results about connectivity of communities of Corophium volutator in the mud flats of the Bay of Fundy. Michael Neubert (WHOI) and Holly Moeller (Stanford) presented various models for fisheries management using bioeconomic models and optimal control. Some of these models included the damage that bottom trawling does to fish habitat.

David Drolet (UPEI, for Andrea Locke, DFO) presented a novel tool for managers to evaluate potential success of eradication programs against invasive species. This tool is based on a statistical analysis of published case studies and can be updated as new studies emerge. Jessica Hearns (Central Florida) reported on recent efforts to re-introduce sea urchins in the coral reef systems in Florida.

On the final day, Ali Gharoumi (UNB) proposed a model to describe the spread of Green Crab along hte Eastern Coast of North America. David Dro-

let (UPEI) answered the question of whether a single introduction of many potential invaders or several introduction of fewer invaders causes a higher probability of establishment. James Watmough (UNB) presented two models for invasive tunicate species and their dispersal patterns around mussel aquaculture sites on PEI. As the final speaker, Emily Moberg (MIT/WHOI) presented a new stochastic method to detect poleward movement of a species distribution in response to climate change.

The workshop gave participants ample time for individual or small group discussions during coffee and lunch breaks. Those opportunities were used widely, and many inspiring insights appeared. The final discussion summarized many of the challenges that emerge for the modeling and management of these aquatic systems.

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AARMS Grant for the Aquatic Systems Network Workshop
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FINANCIAL STATEMENT

Registration Revenue		3,155.85
Costs		
	Transportation	4,536.30
	Accommodation	2,470.64
	Meals	919.50
	Travel Incidentals	40.00
	Taxis & Parking	406.50
	Registration Fees	1,491.26
	Office Supplies	18.38
	Computer Hardware	52.27
	Equipment Rental	394.74
	Food Service	2,432.86
Total Costs		12,762.45
Account Balance		- 9,606.60

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